Analysis of the New Brunswick Industry's position regarding the FOREMOST Project

Submitted to:
The New Brunswick Department of Commerce and Technology

By
The Champlain Institute
Fredericton, New Brunswick

December 1990

Financial assistance under the Canada/New Brunswick Subsidiary Agreement on Industrial Innovation and Technology Development is acknowledged

Analysis of the New Brunswick Industry's position regarding the FOREMOST Project

1. Introduction

During the summer of 1990, some New Brunswick firms involved with integrated forestry planning systems expressed their concern to the Champlain Institute that a proposed NRC project called FOREMOST (Forest Engineering, Management, Operations, and Silviculture Technology) could adversely affect research and development currently being performed in the private sector.

After consulting with several private sector firms and the NB Department of Commerce & Technology, the Champlain Institute submitted an application for assistance under the Canada/New Brunswick Industrial Innovation and Technology Development Subsidiary Agreement to fund a study to identify the impact that the FOREMOST project would have on the New Brunswick geomatics industry involved with integrated forestry planning systems.

In particular, the study was to provide an assessment of:
- The requirements of an integrated forestry planning systems;
- The capabilities of New Brunswick software firms and researchers to develop such a system;
- The work being performed elsewhere in Canada in the same field; and
- The recommended action which will enable the New Brunswick software industry to play a significant role in developing such systems.

The study was performed by FORCE/Robak Associates Ltd during the latter half of 1990.

This document provides an analysis of the New Brunswick industry's position regarding the FOREMOST project.

2. Response from Industry

FORCE/Robak met with 7 other forestry/software development companies in New Brunswick. Firms based in the Fredericton area were contacted in order to reduce the projects costs. In addition to the private sector, discussions were also held with the University of New Brunswick and the Universite de Moncton. These organizations had joined forces in the form of an informal group called the Resource Decisions Systems Association (RDSA) in order to address the issue of the FOREMOST project.

The consultant recognized that there are other consulting and technology firms in New Brunswick who may have relevant experience. However, project constraints precluded the consultant from contacting them.

The findings of the study are presented in a report *Integrated Forest Management Planning System: A New Brunswick response to the FOREMOST Project* prepared by FORCE/Robak Associates Ltd.

In general, the industry supported the goal of FOREMOST to produce an integrated computer-based decision-support framework which "glues" together technologies such as

growth and yield models, forestry records and management systems, forestry geographic information systems, and expert systems. However, the RDSA expressed concern that FOREMOST could adversely affect research and development currently being performed by New Brunswick firms. In particular, a number of companies raised the issue that they had developed specialized markets and that they thought it possible that the activities of the NRC could adversely affect these markets and hence the profitability of the industry.

3. Response from the National Research Council

A shorter report *NRC's FOREMOST Proposal: The New Brunswick response* was prepared by FORCE/Robak Associates on behalf of the RDSA and submitted to the NRC. This report emphasised the RSDA's concern that an apparent strategy of NRC to develop actual forestry planning modules would place components of FOREMOST in competition with products from private sector firms. The RDSA also cautioned that the diversity of physical, social, economic, and regulatory environments faced by Canadian forest product companies precludes the development of a single integrated forestry planning system that would be acceptable to all companies throughout the nation. The report recommended that the NRC should participate in pilot projects across Canada in order to develop the technologies and standards which allow the integration of data and models for planning purposes, and suggested that the databases, models, procedures, and expertise already in place in New Brunswick would make the province an ideal test-site for such a project.

The NRC in response has indicated that industry should not have any concerns that the agency would undertake a strategy which would place it in competition with Canadian companies. NRC has held discussions with Canadian industry representatives to determine the generic aspects of FOREMOST and to determine the needs and priorities of the forestry industry. NRC indicates that it has deliberately avoided involving software companies in these discussions until market requirements and interests have been assessed.

The NRC has advised that its concern is not with getting into the commercial software industry but with precompetitive protocols and developments that can be exploited by Canadian software companies. Consequently, the NRC would welcome New Brunswick software companies as members of the FOREMOST consortium on this basis as the agency views the competence of companies of the RDSA and their close ties to the University of New Brunswick would make them valuable participants.

The NRC has indicated they will initiate further contact with New Brunswick as soon as discussions with the forestry industry have advanced to the point when it is worthwhile to contact potential software developers.

4. Conclusions

The study has revealed that researchers, software developers and forestry practitioners in New Brunswick have the expertise to develop integrated forestry planning systems (IFPS) technology. The Timber Management Branch of NB Dept of Natural Resources & Energy, large forest product companies, the universities, and consulting groups in New Brunswick have gained vital experience, gathered much of the data, and developed many of the models that would be required in the development of an IFPS. New Brunswick's Crown Lands and Forests Act, which has been hailed as a model for other Canadian jurisdictions, has resulted in the development of some of the most advanced and comprehensive information and decision support systems in the country.

Most recently, research and development undertaken by software firms and universities in New Brunswick has focused on identifying the linkages that are required to build integrated systems, and on developing the models which can be incorporated into such systems. The forestry software industry has started to explore the possibility of collaborating on R&D and have expressed an interest in sharing market information and development ideas in areas where their efforts would be complementary, rather than competitive.

New Brunswick's forestry/geomatics firms have the opportunity to build on their internationally recognized strengths in the areas of capture, processing, and analysis of forestry data and to join forces to exploit the growing international market for integrated forestry planning systems. The blend of expertise that could be offered to potential clients in collaborative efforts could be a major selling point for the region's products and services.

Notwithstanding this capability for pursuing research and development within the province, it should be bourne in mind that NRC still considers the FOREMOST proposal to be under preliminary considerations. It is possible that through further discussion with NRC, the major reservations presently held by New Brunswick's industry may disappear. For this reason, the RDSA should keep its options open by pursuing its own R&D agenda while continuing to be receptive to the NRC's activities.

Having received an assurance from the NRC that the agency will initiate further discussions with the New Brunswick software industry as soon as the time is suitable, the Institute has largely completed its role in this venture. The Institute considers it appropriate that future discussions will take place directly between the RDSA and the NRC. The Institute, will however, continue to provide what support it can to the province's industry.

NRC's FOREMOST Proposal:
The New Brunswick Response

Submitted to:
The Champlain Institute
and
The New Brunswick Department of Commerce and Technology

By
FORCE/Robak Associates Ltd
Fredericton, New Brunswick

December 1990

Financial assistance under the Canada/New Brunswick Subsidiary Agreement on Industrial Innovation and Technology Development is acknowledged

NRC's FOREMOST Proposal:
The New Brunswick Response

Introduction

The Canadian forest industry, our leading exporter, can undoubtedly benefit from the development of procedures and tools which facilitate the integration and rationalization of strategic, tactical and operational plans. Besides helping to improve the forest industry's efficiency, the effective implementation of such integrated systems would help organizations analyze (and reduce) business and forest management risks and enhance their ability to document plans and justify them to regulatory agencies and the public.

In areas of the world where there is a long history of intensive forest management, forestry organizations have usually established clearly defined procedures for incorporating long-term forest management strategies in tactical and operational planning and control mechanisms. However, these procedures are usually manually-based, time-consuming and inadequate for the kinds of situations faced by most modern forest product enterprises. For these reasons, there are currently several initiatives (in North America, Europe, New Zealand and Australia) which are intended to lead, eventually, to the development of computer-supported integrated forestry planning systems (IFPS). One of the main reasons that IFPS technology is not further advanced is that much of the hardware and software required to make it feasible has only recently been developed. In fact, with its internationally-recognized strengths in the areas of forestry data capture and processing and decision support, Canada is well-positioned to take a lead in this area: it could still establish itself as the main supplier of IFPS technologies and expertise.

This is not to say that a generic, universally-acceptable IFPS could be developed for this market. Even if site-specific, integrated systems existed, it is certain that they could not be directly adopted by other companies since an IFPS must be custom-designed to suit a particular situation and organization. In fact, the diversity of physical, social, economic and regulatory environments faced by

Canadian forest product companies precludes the development of a specific IFPS that would be acceptable to all companies nationally or even provincially. Nonetheless, some models (components of an IFPS) might find widespread (even universal) acceptance in the industry, and there is a strong case that can be made for the development of the standards and technology which would facilitate the data and information transfer required for proper plan integration.

IFPS in New Brunswick

Researchers, software developers and forestry practitioners in New Brunswick have been working on various aspects of integrated planning for many years. The regulations and practises prescribed by New Brunswick's Crown Lands and Forests Act have been hailed as a model for other Canadian jurisdictions. In order to accomplish the goals of the Act, it has been necessary to develop some of the most advanced and comprehensive information and decision support systems in the country. The Timber Management Branch of DNRE, large forest product companies, the universities and consulting groups have gained vital experience, gathered much of the data and developed many of the models that would be required in the development of integrated forest management (or forestry) planning systems (IFPS). Most recently, research has been undertaken at the universities which is aimed at investigating the nature of the linkages that will be required to develop IFPSs. As well, New Brunswick researchers and software development firms have begun to develop integrative models and systems which could be incorporated into integrated planning systems. A properly-constituted national initiative related to integrated forestry planning must take into account the work that has been and continues to be accomplished in this province.

Cause for Concern

In June of 1990 various New Brunswick researchers and developers learned of a draft proposal from NRC for a project (called FOREMOST) which appeared to be aimed at the development of a national IFPS. This knowledge did not come directly from NRC, but rather was the

result of information supplied by forest product companies and a national research institute. These organizations, who had been or expected to be asked to participate in the NRC initiative, were confused about how this proposal was related to public and private research and development that they were aware of in New Brunswick (and elsewhere). A copy of the draft proposal was subsequently acquired and perused by many of the New Brunswick groups and individuals who were working in this area (hereafter referred to as the Resource Decisions Systems Association or RDSA). The immediate opinion of the group was that this initiative could have a significant negative impact on research, development and commercialization projects in this province.

The concern of the RDSA increased when it was learned that NRC refused to permit a New Brunswick researcher/developer to attend a meeting to represent the group and learn more about the proposal, despite requests from the Forest Engineering Research Institute of Canada (FERIC) and the New Brunswick Dept. of Commerce and Technology. At this NRC-hosted meeting, which was held in Ottawa in late June, an updated FOREMOST prospectus was presented to attendees from forest product companies, Forestry Canada and FERIC. An evaluation of the amended prospectus and NRC's subsequent presentation of the FOREMOST proposal to interested New Brunswick researchers, developers and practitioners (in Fredericton on Sept. 27th) did nothing to alleviate these concerns. Instead, it appeared to confirm that the NRC personnel had an imperfect understanding of the integrated planning problem, how it should be solved and the implications of the strategy it had apparently chosen.

Evaluation of the FOREMOST prospectus:

The overall objective of FOREMOST, to produce an integrated forestry planning DSS framework, is quite supportable. The development of a user-friendly, flexible, multi-platform DSS shell or "connectivity-facilitator" (the G.L.U.E.) that could be used in the forestry planning environment would be a valuable achievement. However, the proposal reveals aspects of the project which are

technically questionable and procedurally objectionable.

It would appear that the proposal's emphasis on object-oriented programming software (OOPS) and the AUDITION package is related to the goal of producing a DSS framework. However, the reasons for using OOPS technology in this regard are not well explained in the proposal and questions about this issue from information science researchers and developers in Fredericton were not adequately answered. It is possible that the application of OOPS technology to the development of a DSS framework may be valid, but the proponents should be able to justify this. The "user-friendliness" of OOPS is not adequate justification, especially in light of the fact that much of the DSS framework would be transparent to the user.

The development of national standards, which is implied in the development of a national IFPS framework, must be of great interest to software developers, system integrators and the information systems managers of forest product companies and government departments. The proposal and presentation did not make clear how data structure, communication and other relevant standards would be established or who would be involved. This is worrisome since the NRC researchers do not appear to have consulted with knowledgeable forestry information system researchers, developers and practitioners (and may not know who they are: they were not aware of the existence of an international geographic information system firm whose head office is in Fredericton, for example).

When the project proposal strays from its declared general objectives, further problems are exposed. An analysis of the proposal's DELIVERABLES and TECHNICAL sections reveals that much more than a DSS framework is promised. The scope of the deliverables is said to include "the development of prototypes for each level of planning and scheduling, and for the G.L.A.S.S. and G.L.U.E.". Yet this contradicts an earlier statement that "the scope of FOREMOST will not include ... any other models required in planning", and is not consistent with the goal of the project. According to some delegates at the June meeting, this ambiguity was not resolved: the industrial attendees were given the impression that they would receive a working

IFPS in return for their participation. The problem is not merely one of ambiguity and inconsistency. There are some valid objections to NRC's apparent strategy to develop actual forestry planning system modules, primarily related to questions of competence and competition:

- NRC does not appear to have expertise in this area. It is obvious that researchers and developers involved in the design and development of forestry information and decision support systems in Canada were not involved in the development of the proposal and had not even been consulted about it. The FOREMOST prospectus does not exhibit an adequate understanding of forestry planning processes or the steps required to integrate them.
- The development of planning modules would put components of FOREMOST in competition with products from private software firms, may involve the infringement of copyrights and would dilute the primary emphasis of the project: the development of a DSS framework. It seems that a significant share of the project's development effort will be aimed at producing short-term planning and scheduling systems, some of which have already been developed and are commercially available.

Recommendations:

The basic justifications for and objectives of the FOREMOST proposal are valid. A good DSS framework would facilitate the development of useful and useable situation-specific integrated forestry planning systems. However, the emphasis of the FOREMOST project must return to the development of the DSS framework (where a good deal more work is warranted), and the technical section of the project must be restructured so as to reflect that change in emphasis. The design, development and implementation of new planning modules (or modification of existing ones) for a specific IFPS must be left to the software firms, consultants, researchers and practitioners who have the knowledge and experience to do so. If this is not done, not only will FOREMOST fail, but its existence will delay other valid research and development projects in this area and may discourage the forest

industry from participating in future IFPS projects.

In order to develop and evaluate the various technologies and standards which might contribute to an IFPS framework, it is suggested that NRC cooperate with groups across Canada who are capable of establishing pilot project sites. This would encourage the involvement of knowledgeable groups and individuals, resulting in a truly national effort. For instance, work on integrated planning systems has progressed far enough in New Brunswick to warrant the establishment of a vertically-integrated forestry planning system demonstration project. Since New Brunswick is probably farthest along with respect to the data, models and procedures required for an IFPS, this proposed demonstration project could act as "workbench" and test site for the technology NRC proposes.

Whether or not such a restructuring occurs in the FOREMOST project, New Brunswick's researchers and developers will continue their work on information systems and integrated planning techniques and technologies for forestry. For these reasons, it is vital that NRC:

1) abstains from getting involved in the development of software or systems in competition with software developers;

2) promotes the participation of knowledgeable and interested developers and government agencies in the development of standards;

3) promotes the FOREMOST project to the forest industry as an initiative that will deliver a framework as opposed to a completed and implementable IFPS;

4) involves representatives from the forestry planning technology R&D community in its future meetings with the forest industry.

The Resource Decisions Systems Association

The Resource Decisions Systems Association (RDSA) is an informal association of software and system integration firms, consultants and researchers in New Brunswick who have established reputations in the research, design and development of forestry planning technologies. They are particularly interested in issues related to integrated forestry planning systems (IFPS).

Organizations involved:

Advanced Systems Design Ltd.

E^3 Inc. (Electronically Enhanced Education)

FORCE/Robak Associates Ltd.

GEODAT Information Services Ltd.

R/EMS Research Ltd.

Rockwood Informatics

Universal System Ltd.

School of Forestry, Université de Moncton

Faculty of Forestry, University of New Brunswick

INTEGRATED FOREST MANAGEMENT PLANNING SYSTEMS:

A New Brunswick Response to the FOREMOST Project

Submitted to:
The Champlain Institute
and
The New Brunswick Department of Commerce and Technology

By
FORCE/Robak Associates Ltd
Fredericton, New Brunswick

December 1990

Financial assistance under the Canada/New Brunswick Subsidiary Agreement on Industrial Innovation and Technology Development is acknowledged

INTEGRATED FOREST MANAGEMENT PLANNING SYSTEMS: A NEW BRUNSWICK RESPONSE

Submitted to:

The Champlain Institute

And

The New Brunswick Department of Commerce and Technology

By FORCE/Robak Associates Ltd.

Fredericton, New Brunswick

SUMMARY

A National Research Council (NRC) initiative for the development of an integrated forest management planning system has prompted a study of the capabilities of New Brunswick companies and individuals to undertake such work. After providing a background to the situation that was the motivation for this study, integrated forest management (or forestry) planning is explained and a system development approach is proposed. The requirements for an integrated forestry planning system (IFPS) are then compared to the capabilities of New Brunswick software firms and researchers. The major North American IFPS projects and initiatives (with a special emphasis on NRC's FOREMOST) are then reviewed and evaluated, and issues relating to the participation of groups and individuals from this province are discussed. Finally, recommendations are made regarding responses that can be made by the forestry software industry to the FOREMOST project and to the development of IFPS technology, including a proposal for a "made-in-New Brunswick" project.

SECTION I - INTRODUCTION

Background:

In June (1990) forestry researchers, software developers and system integrators in New Brunswick were apprised of a National Research Council (NRC) initiative to develop a national integrated forest management (or forestry) planning system (IFPS). This information, which came indirectly from several third-party sources, was the first intimation of the proposed FOREMOST project for most New Brunswick researchers, developers and integrators. While a few had seen the NRC-based IFPS concept presented in very general terms at an industry conference, this was the first hint that the proposal had moved beyond the conceptual stage. This second-hand information was the first to describe the FOREMOST project clearly enough for the province's forestry software community to become worried about it. This concern was only increased when copies of the first FOREMOST prospectus were finally obtained (again indirectly) and discussed at a mid-June meeting of individuals and organizations who were thought most likely to be affected by it.

Certainly one concern of the group (designated, for the interim, as the Resource Decision Systems Association or RDSA) was that New Brunswick's IFPS researchers and software firms were not consulted about the project. Considering the fact that, in areas relevant to IFPS and the FOREMOST project, these researchers had obtained significant funding in national research competitions and the developers were competing successfully in world markets, it seemed that their expertise was being deliberately disregarded. This suspicion appeared to be confirmed when NRC personnel refused to allow a representative of the New Brunswick group to sit in on a NRC-sponsored presentation to the forest industry, despite requests from the Forest Engineering Research Institute of Canada (FERIC) and New Brunswick's Dept. of Commerce and Technology. Although the reason given for this refusal was that the meeting was only intended to identify the needs of the industry, the agenda of

the meeting and the nature of the second FOREMOST proposal (sent to prospective participants shortly before the meeting) suggested that the goals were much more extensive than stated.

The objections of RDSA to the second FOREMOST prospectus went far beyond the apparent snub of the group, however. For one thing, although the stated goal of the FOREMOST project is to provide a decision support technology framework, the development of certain application software was envisaged which was seen to duplicate (and presumably would compete with) packages that have been designed, developed and marketed by New Brunswick companies. As well, those who had worked longest and hardest at developing integrated forestry planning technology in New Brunswick wondered whether potential clients (or research collaborators) would tend to delay their purchases (collaborations) while this national IFPS effort continued. If the NRC project went ahead and failed, the forest industry would probably shy away from IFPS projects for a long time to come. On the other hand, if FOREMOST succeeded, it was possible that various data, modelling and dialogue standards would be developed which might be detrimental to the interests of private-sector members of RDSA. Finally, since it appeared that the bulk of the technical work would be overseen (if not carried out by) the NRC laboratory in British Columbia, the likelihood that New Brunswick players would be able to participate in or influence the project was seen to be small.

However, since NRC was to develop a new proposal in response to criticisms from the forest products companies who were potential participants, there was some hope that the fears of the RDSA would be alleviated by modifications to the proposal. Besides disagreeing with some parts of the prospectus, the forest industry people at the meeting in Ottawa were not willing to describe all their integrated planning system needs in a two-day session. Most participants, however, did agree to continue exploring the FOREMOST idea. The conclusion of the meeting was that the following steps would be taken:

- The forest product companies would supply more information

concerning their needs and current capabilities (to be supplied by early September).

- A revised proposal (presumably based upon what NRC had learned at the June meeting and from the later survey of the companies) would be presented to the forest sector organizations at another meeting in mid-October.

- It was only after this meeting that other participants (primarily software developers) would be brought in for a meeting in November at which time they would be given an opportunity to indicate interest in participating.

- Then a final proposal would be sent to all potential participants in January 1991 at which time they would have to decide if they wished to participate.

Apparently as a response to the concern expressed by the N.B. Dept. of Commerce and Technology on behalf of the RDSA, NRC presented its FOREMOST project proposal at a meeting in Fredericton on September 27th. At this presentation the RDSA hoped to learn that the FOREMOST proposal and NRC's approach had been modified to take into consideration its concerns. However, the ideas presented at that meeting were not significantly less worrisome to the group than what had been learned through study of the prospectus and other second-hand sources.

This report, commissioned by the Champlain Institute and the N.B. Dept. of Commerce and Technology on behalf of the N.B. forestry and related software R&D community, is intended to:

- provide a definition of integrated forestry planning systems and a description of relevant design and development issues;

- summarize the capabilities that exist in the province to design and develop such systems;

- describe and evaluate the FOREMOST proposal;

- describe other projects have been proposed or initiated in this subject area;

- and recommend alternative responses for software companies, university researchers and institutes, consultants and government departments with respect to FOREMOST and, more generally, integrated forest management planning.

SECTION II - INTEGRATED FORESTRY PLANNING SYSTEMS

Scope and Terminology

Before defining and describing forest management planning systems, it may be worthwhile to address the question of why the focus is on planning systems, rather than management systems. After all, planning systems must be designed to work with systems developed to support other management decision-making, such as those related to control. However, in order to maintain consistency with some of the other literature cited herein and to economize on the scope of this report, these other aspects of management will only be addressed where it appears necessary.

As well, the terminology used when referring to forest management planning needs some clarification. Since planning is usually an element in the management function, the term forest management planning appears somewhat redundant or confusing. It helps to understand that the expression "forest management planning" often refers primarily to the planning of the biological resource itself: ie. to the establishment, growth and maintenance of forests. Unfortunately, when integrated planning systems are discussed, "forest management" tends to take on a broader meaning which would encompass forest resource planning, forest operation planning and related management issues. In fact, it can be argued that "forestry planning" might be a better term to use, but "forest management planning" and "forestry planning" will be used interchangeably in this report.

Integrated Planning

The planning process of the woodlands departments of forest product companies "is based on a sequence of planning stages that encompasses different time horizons and activities" (Eriksson, 1987). Besides planning the proper application of the firm's human, financial and capital resources, managers must also produce operational and strategic plans for the management of a renewable resource. Various levels of management must undertake planning

activities that range from (for example):

- the analysis and design of a forest resource management plan over a rotation (usually between twenty and a hundred years);
- to the development of industrial strategies that span decades;
- to capital investment planning (five to ten years);
- to annual operational planning;
- to monthly, weekly and even daily re-planning and scheduling.

A major problem for management is to link and control these various plans in such a way that both long and short-term objectives are achieved throughout all departments of the organization. Unfortunately, these objectives and constraints can often be contradictory or mutually exclusive. Managers responsible for the firm's long-term forest resource management may not share the same goals and are often not evaluated according to the same criteria as managers responsible for operational activities. Complicating the matter for most forest product companies is the fact that inconsistent government regulations and societal restrictions often send conflicting messages to the various departments and levels of management.

Although the problem of internal goal conflict must eventually be resolved within the organization, the various management groups must first get to the point where they understand where the areas of conflict truly exist. When all groups are "speaking the same language" they may find that some areas of apparent conflict can be resolved using innovative methods and/or compromise. In order to properly identify and analyze new approaches and compromises, each group must be able to describe its planning ideas in a way that can be understood and evaluated by the others. Furthermore, a better initial understanding of the objectives and constraints of other groups in the organization should result in more efficient and effective decision-making on the part of all managers. In essence, what is required is a more integrated planning process.

This is not a problem that is peculiar to Canadian forestry.

Internationally, in recent years, forest management and forest operation researchers and practitioners have placed a higher priority on linking planning processes. A computer search of various on-line databases reveals hundreds of papers on this subject, with a marked increase in recent years. At the 1990 World Congress of the International Union of Forest Research Organizations (IUFRO), at least three sections that deal with forestry planning or information systems have declared that integrated planning will be a major theme for their future conferences. In discussions with forest product companies around the world, this authour has found that the most progressive organizations are putting a significant effort into developing more coherent and coordinated planning methods. As well, since there has been steady (if slow) progress in the development and implementation of information systems that support elements of the forestry planning process, it is reasonable to suggest that these systems should also be integrated. Nevertheless, although some interesting work is being done, an extensive literature search and discussions with researchers and practitioners in this field indicate that nobody has developed a definitive framework for integrated planning, much less an integrated system.

The design problems associated with the development of integrated forestry planning systems (IFPSs) are both conceptual and technical. Before technical specifications relating to data structures, data transfer, modelling and dialogue languages and presentation techniques can be adopted, designers should understand the relationships between planning decisions and decision processes. It should be obvious that technical integration without conceptual integration would be invalid. However, a lack of technical integration will result in a process that is cumbersome and not supportive of integrative decision-making.

When the concept of an IFPS is discussed, certain common modelling and data elements are usually included. An idealized integrated system could include the following elements:

1) forest inventory data and models;

2) growth and yield data and models;
3) other silvicultural, biological and physical data;
4) harvest scheduling and forest management planning models;
5) other industrial strategic planning (capital acquisitions, infrastructure) data and models;
6) operational (harvesting, wood transportation, stand establishment, support functions) analysis, planning and scheduling data and models;
7) a geographic information system with strong modelling capabilities for integrating and utilizing much of the spatially-oriented data mentioned above;
8) expert systems for areas requiring specialized knowledge (such as environmental impact forecasting);
9) data, model and dialogue management technologies that facilitate: the gathering, storage, updating and sharing of data; the linkage of data to models and models to each other; and the integration of decision processes.

As indicated earlier, the time-frames that must be addressed by an IFPS vary from planning over a crop rotation to weekly or even daily planning and scheduling models.

System Development Approach

Although there is a worldwide need for IFPSs and common principles underlie the planning processes they would support, it is unrealistic to expect that a single integrated package could be developed which would suit all forestry companies even in a single region of a country. Variations in objectives, resources, constraints, management philosophies, corporate policies and government regulations ensure that each organization has a unique management situation. Information systems must be designed to support those circumstances, not some typical or ideal situation that exists only in the mind of a system's promoter. For instance, a forest operation planning decision support system, OP-PLAN, has been evaluated by many dozens of managers around the world and has

been found to be valid, generally, for all forest products enterprises. However, even though a conscious attempt has been made to keep the system as flexible as possible, it is recognized that it would have to be custom-designed to suit each and every organization that would use it as management tool. Similarly, trying to develop a generic integrated forestry planning package may produce something that is useful to nobody. There is a need for situation-specific solutions that are made up of conceptually and technically linked systems, models and databases. This will necessitate a modular design approach so that both flexibility and utility of a specific implementation are maintained.

There are several reasons why it is likely that no two integrated planning systems will be the same, and these are largely related to the system design modifications necessitated by variations in the following factors:

1) the objectives, philosophy and structure of the organization;

2) the decisions and decision-making processes that the system is intended to support;

3) the information presentation requirements (including preferences regarding the format and nature of reports and interface screens);

4) the characteristics of existing or potentially acceptable systems, models, databases and methods that may be incorporated into the integrated system;

5) the elements to an integrated system which are currently undeveloped in a particular situation (usually models or data);

6) and the perceived cost/benefit trade-offs associated with various degrees of system integration.

It should be understood, however, that there will be specific systems, models and database structures which will have wider (though not universal) application. As well, some technologies are certain to be more conducive than others to the development of integrated systems and integrative decision processes. Perhaps the most universally-saleable "product" that can be developed, however,

is the kind of experience and expertise necessary to analyze, design, develop and implement an effective, situation-specific, integrated forestry planning decision support system.

New Brunswick's IFPS Capabilities

If the foregoing explanation of issues relating to integrated forestry planning system (IFPS) structure and development approaches can be accepted, then a strong argument can be made for the significant participation of New Brunswick researchers, developers and system integrators in an IFPS development project. In the province's public and private sectors there is expertise in all of the areas of integrated system design and development. In fact, considering the substantial, acknowledged experience that many New Brunswick organizations have in the development of working models and technologies that would be components of a useful integrated system, there is every reason to believe that such a project could be led from this province.

Appendix I of this report briefly describes the results of a survey of New Brunswick organizations that have experience in areas that are pertinent to IFPS design and development. This list is <u>not</u> exhaustive: DNRE is not included, not all consultants have yet responded to this survey and it is certain that there is relevant expertise (eg., with respect to development languages, data acquisition, modelling) in other departments of the universities and in other organizations. Nonetheless, a summary of this survey reveals the following:

A) Université de Moncton and University of New Brunswick: Forestry researchers at UNB and U de M have undertaken projects in growth and yield modelling, wood supply analysis, harvest scheduling, harvest distribution and transportation modelling, forest operation planning, GIS technology and its modelling applications, remote sensing and economic analyses. Furthermore, many of these and other research projects have been specifically aimed at technical and/or conceptual system integration issues. It should be noted that these projects are seen as topical and valuable by the forestry sector and funding was often obtained in national research competitions.

B) Advanced Systems Design Ltd: ASD has expertise in data

acquisition and data communication with specialization in industrial computer-based data acquisition, data communications and computer networks, and general system integration via communication networks (from LANs to MSAT satellite networks). ASD has developed commercial Log and Lumber Tally Systems and data collectors which are part of integrated systems where field data is sent via cellular telephone or MSAT satellite to central computer systems for immediate processing and verification.

C) FORCE/Robak Associates Ltd: FRA is engaged in the design, development and servicing of information and decision support systems that are being used by forest product companies, consultants, woodlot owners associations, a national research organization, government departments, and educational institutions in eight countries. Projects have included the design and development of systems for: maintaining forest inventory databases; logistical and financial analysis of harvesting and transportation systems; and the integrated planning, scheduling and control of forest operations.

D) GEODAT Information Services Ltd: GEODAT specializes in providing fully integrated remote sensing, GIS and digital mapping services. GEODAT is involved in the monitoring of acid fog effects, monitoring and map production of clearcuts and forest fire depletions using LANDSAT-TM imagery; and research in the area of satellite forest inventory, insect and fire damage assessment, species identification, stand classification and delineation. In addition, GEODAT has the capability to carry out broad based environmental assessments (monitoring of soil erosion, pollution effects, drainage patterns and forest vegetation moisture stress) using satellite imagery and is one of the few companies in Canada that have an established digital link between an Image Analysis System and a GIS. GEODAT has worked with the most popular GIS technologies on the market today including SPANS, ARC/INFO, CARIS, INTERGRAPH and GEOBASE. GEODAT has a subsidiary, OPTEX Inc., which specializes in software development for imaging/optical scanning and storage systems.

E) R/EMS Research Ltd: R/EMS specializes in software development and consultation in resource management particularly with regard to wildland fire management and environmental assessment. The company has designed and developed systems for gathering and analyzing large amounts of data and transforming them into useful graphical information. R/EMS has undertaken many resource management consulting projects including the development of national park management plans, wood supply analysis, harvest modelling, development of a GIS database, development of a fire growth model with a leading GIS company, and the design of satellite capture and filtering software for a national fire danger display system.

The personnel at R/EMS have extensive experience developing simulation models and decision support systems incorporating computer graphics, and interfacing these with existing technologies such as a GIS, all within a forest management context. R/EMS has clients in universities, the government and industry in every province and territory in Canada, in New Zealand and are currently exploring markets in the U.S., Australia and China.

F) Rockwood Informatics: Rockwood is engaged in the design and development of microcomputer software and the development, integration and servicing of large-scale systems. It has the ability to offer both hardware and software solutions in the areas of systems integration, software system design, development and production, knowledge engineering and expert systems development. (The company is currently developing an expert system for the New Brunswick Dept. of Natural Resources (DNRE) to help in the management of deer populations). As well, Rockwood provides a variety of data processing consulting services including strategic planning, evaluation of proposals and feasibility studies, and support services such as user training, hardware and software maintenance, data entry and backup services.

G) Universal Systems Ltd: USL is a software and systems integration company that has developed (and markets and supports) a GIS called CARIS. The CARIS system has extensive applications in the management of land and marine resource industries and in digital mapping (including forest management, topographic mapping, remote sensing, and transportation). CARIS is capable of supporting full topology, true three-dimensional data structures and an integrated raster/vector environment. CARIS is available on many hardware platforms, operates under both VMS and UNIX systems, and incorporates industry standards such as X-Windows and Motif on all its applications. USL's emphasis on R&D has resulted in an expanded diversity of CARIS applications which in turn has led to an increased client growth. USL's forestry clients include: Fletcher Challenge, PEI Energy & Forestry, BC Crown Lands, and Manitoba Natural Resources. In addition USL boasts an international clientele including: The Port of Singapore, Denmark Survey and Cadastre, Egypt Soils & Water, Deutsches Hydrographisches Institut, Netherlands Hydrographic Service, and Geographic Information-Australia.

Other Expertise in the Province: The design, development and support of integrated forestry planning systems will benefit from the availability of a wide variety of other talents in New Brunswick. For instance, the implementation of multi-user, distributed integrated planning systems may well require the application of new and innovative training techniques: Electronically Enhanced Education (E^3) is a highly-regarded

New Brunswick firm with expertise in the area of computer-based education and training. As well, as stated above, there are other individuals and groups in NB who have expertise relevant to IFPS, whether in relation to integrated planning in general or specific modelling, data or computer technology topics. Personnel in the Timber Management Branch of DNRE have much experience in the use of GIS and models in forest management planning. Other university departments conduct research and development in GIS and fields related to software integration. There are certainly other consulting and technology firms in the province who would have relevant experience but who have not yet responded to this survey.

In summary, if an inventory of the reported capabilities of responding NB organizations (see APPENDIX I for details) are matched with the suggested essential features of an IFPS, it is possible to create the following list of organizations that have had experience/expertise in the relevant areas:

1) forest inventory data and models: Advanced Systems, FORCE/Robak

2) growth and yield data and models: U de M

3) other silvicultural, biological and physical data: U de M, UNB

4) harvest scheduling and forest management planning models: UNB, R/EMS Research

5) other forest industry strategic planning models: U de M, UNB, FORCE/Robak, R/EMS Research

6) operational data and models: FORCE/Robak, UNB, U de M, R/EMS Research

7) GIS and related technologies: Universal Systems, UNB, Geodat, R/EMS Research, U de M

8) expert systems: Rockwood

9) data, model and dialogue management technologies: Advanced Systems, Rockwood, Universal Systems, FORCE/Robak, R/EMS Research, Geodat, OPTEX, UNB

As well, many of the above-mentioned organizations have experience in needs analysis and system design, development and implementation.

SECTION III - INTEGRATED FOREST MANAGEMENT SYSTEM INITIATIVES

There are currently several ongoing or proposed IFPS development projects which should be of interest to New Brunswick researchers and developers. Since the proposal from NRC was what originally provoked the discussions of the RDSA and this report, it will be the one which will be addressed first.

THE FOREMOST PROPOSAL

Summary of the FOREMOST Proposal:

The stated objective of FOREMOST is "to develop an integrated decision support technology, which builds upon the forest-land knowledge-base (e.g., forest inventory, GIS, growth/yield models, silviculture, etc.), to assist with the preparation, implementation and monitoring of long, medium and short term forest engineering, harvesting and silvicultural plans and schedules". The project is intended to provide "a decision support technology framework" to integrate existing technology ("linking with company/organization specific management information systems and models") and "is not intended to be a replacement for existing forest management information systems", nor will it "include the development of data models, GIS information models, growth and yield models, protection models or any other models required in planning".

In the FOREMOST technical plan it is stated that the conceptual design of the project includes seven stages or sections:

1) Short Term Scheduling, "to support the short-term scheduling needs of harvesting and silviculture activities at the cut-block level";

2) Annual, Operational Planning, "to support the preparation of the annual operating plans" by dealing with "design of harvest, sequencing of cut-blocks, silvicultural prescriptions, protection and reclamation activities" and ensuring that mill requirements are fulfilled;

3) Five Year Planning, "to support the preparation of 5 year plans" that must include decisions concerning "forest access and road construction, harvest schedules, general cut-block design,

overall timber requirements, silvicultural options, all in relation to the various demands of the forest-land resource".

4) Twenty Year Planning, "to support decisions concerning the tactical implementation plan for the tenure, net land base evaluation, annual allowable cut calculations, twenty year allocation strategy and harvest sequencing for five-year operating areas, infrastructure development, and reforestation objectives and strategies".

5) Forest-Land Resource Management Planning, to support decisions relating to long term (80 to 150 years) "land and forest allocation strategies, environmental impacts, and economic viability".

6) Graphically Layered Application Support Systems (G.L.A.S.S.), to provide a set of tools to "facilitate manipulation of assumptions, ... preparation of alternate plans and schedules, and evaluation of results".

7) Graphically Layered User Environment (G.L.U.E.), "to provide linkages between all the above stages and any software products external to FOREMOST".

NRC, which is behind the FOREMOST initiative, is very enthusiastic about using object-oriented programming software (OOPS) and, in particular, a package called AUDITION. AUDITION (and its associated theatrical paradigm) is declared to be the technological driving engine which will make FOREMOST a success. The stated advantages of OOPS technology are that:

1) an object can be developed and refined incrementally

2) multiple copies can be made and then specialized

3) objects can be generalized to higher levels of abstraction (ie, combined to form one object)

4) objects can be re-used wherever required

5) decision makers can relate to object because it can be made to look like the real-life object

6) objects allow for a visually rich interactive decision environment which can convey lots of intuitive information to the user.

For a more detailed description of the project, see the June 1990 FOREMOST Prospectus.

Evaluation of the FOREMOST Proposal

The following is an evaluation of FOREMOST primary objective and the strategies proposed to achieve it. A more detailed critique of elements of the proposal's Technical Plan is contained in APPENDIX II.

The FOREMOST proposal does aim to satisfy some real needs in the forest industry. The description of some of the problems associated with current forestry planning processes are generally sound. According to the authours:

- present planning procedures are cumbersome and inflexible;
- present planning procedures are not well integrated;
- present focus of computer applications is on automating traditional information systems;
- there is a lack of some fundamental data and knowledge;
- professional experience is disparate and dispersed;
- existing software packages are not well integrated.

Good arguments can be made to support these assertions and the interest of forest industry managers in the FOREMOST proposal must be, to some extent, based on their recognition of these problems. The overall objective of FOREMOST, to produce an integrated forestry planning DSS framework, is also very supportable. The development of a user-friendly, flexible, multi-platform DSS shell or "connectivity-facilitator" (the G.L.U.E.) that could be used in the forestry planning environment would be a tremendous and valuable achievement. The proposal's emphasis on object-oriented programming software (OOPS) and AUDITION is clearly related to this primary objective. Although the package proposed may or may not be the most appropriate (AUDITION is not yet available commercially), it is quite possible that the application of OOPS technology to the development of a DSS framework may be valid.

However, it is when the project proposal strays from these declared objectives (developing a DSS framework) that it begins to reveal flaws. An analysis of the proposal's DELIVERABLES and TECHNICAL sections reveals that much more than a DSS framework is promised. The scope of the deliverables is said to include "the

development of prototypes for each level of planning and scheduling, and for the G.L.A.S.S. and G.L.U.E.". Yet this contradicts an earlier statement that "the scope of FOREMOST will not include ... any other models required in planning", and is not consistent with the goal of the project. The problem is not merely one of inconsistency. There are at least three valid objections to NRC's strategy to develop an actual forestry planning system:

1) The FOREMOST prospectus does not exhibit an adequate understanding of forestry planning processes or the steps required to integrate them. The proposal does not adequately address the basic questions related to the design and development of an IFPS: which decisions need to be made at the various stages of the integrated planning process; what information needs to be conveyed to the user at the appropriate times so that good decisions can be made; and what data and models are required to provide this information. A primary goal of the project is to support integrated decision-making, but there is practically no mention of the kinds of data and information which must be passed between planning levels so that this linkage actually occurs. Decisions made at any one of the levels may effect the costs, benefits or risks of alternatives at other levels, but there is little discussion in the proposal of what these integrative decisions are.
The proposal stresses integration of the various levels of planning, but almost ignores the integration required WITHIN, for instance, operational planning where a lack of recognition of the relationships between harvesting, wood transportation, road construction, silviculture and support functions leads to sub-optimization. As well, the proposal does not adequately address the financial and investment aspects of decision processes. (For more details, see APPENDIX II of this report.)

2) The technology which seems to be advocated for the development of IFPS components (OOPS and AUDITION) is not justified except, perhaps, for its application as a "G.L.U.E.". An over-emphasis on a particular technical feature may mean that other appropriate development technologies may not be employed because they are not OOPS. In fact, many of the advantages of OOPS can be obtained using other modern development environments. Although the visual richness and realism that can be attained through the use of OOPS technology may be of great benefit in certain decision processes, there is no evidence that this is the case in all parts of the integrated planning process. For example, in the case of short term scheduling, it is quite reasonable to expect that managers may be able to "relate" to actual pictures of the limited number of pieces of equipment that would work on a few areas. However, is this still true in the case of a full scale operational plan

involving hundreds of machine occurrences and cut-blocks? In some cases realistic visualization using theatrical paradigms may be helpful, but in other, more complex decision processes it may actually cause confusion.

3) the development of planning modules appears to put components of FOREMOST in competition with private software firms and may involve the infringement of copyrights. It seems that a significant share of the project's development effort will be aimed at producing short-term planning and scheduling systems, putting NRC in competition with the private sector and diluting the primary emphasis of the project: the development of a DSS framework.

In summary, the basic justifications for and objectives of the FOREMOST proposal are valid. A good DSS framework would facilitate the development of useful and useable situation-specific integrated forestry planning systems. However, the emphasis of the FOREMOST project must return to the development of the DSS framework, and the technical section of the project must be restructured so as to reflect that emphasis. The design, development and implementation of new planning modules (or modification of existing ones) for a specific IFPS must be left to the software firms, consultants and researchers who have the knowledge and experience to do so.

New Brunswick Participation in FOREMOST

As described earlier in this report, New Brunswick firms and consultants have, collectively, much of the expertise required to design and develop integrated forestry planning systems and, therefore, to participate in a properly structured FOREMOST project.

Faculty and students of forestry at UNB and U de M have conducted research and developed technologies that are relevant to FOREMOST's short, medium and long-term forestry planning goals and some of its technical (G.L.A.S.S. and G.L.U.E.) objectives. The following is a partial list of potentially relevant topics: Forest Growth and Yield Modelling, Wood Supply Modelling, Harvest Distribution and Wood Transportation Modelling, Optimizing Five-Year Harvest Plans, Linking Operational Planning and Harvest Scheduling, Linking Remote Sensing and GIS, Linking Site Classification and GIS for Forest Management

Planning, Forest Renewal and Protection, Integrating Wood Supply and Logging System Optimization Models, Design of Object-oriented Raster Data Structures and Efficient Raster Functions. These projects are not only relevant to the FOREMOST proposal, they exhibit an understanding of integrated planning issues that would be required to make an IFPS project a success.

FORCE/Robak's OP-PLAN DSS can be used to support integrated decision-making for short-term scheduling, operational planning and 5-year planning. Although it does not currently employ OOPS (in some cases, such as short-term scheduling, such dialogue technology might be beneficial), the fundamental design of the OP-PLAN system is sound: it has been evaluated and supported by operation managers around the world. Current research efforts in the company (and at UNB) are aimed at developing linkages with GIS and strategic planning models.

R/EMS Research has experience with developing forest management simulation models and decision support systems incorporating computer graphics linked to existing technologies such as a GIS. They have developed GIS databases, fire growth models and satellite data capture and filtering software. They have also undertaken forest management analysis and planning for clients, thereby testing and applying the technologies they (and others) have developed. Much of the experience of this firm is relevant to various levels of planning described by the FOREMOST prospectus, and to the development of the "G.L.A.S.S." and "G.L.U.E." required for technical system integration.

Although the FOREMOST proposal can be faulted for its over-emphasis on questions related to computer technology, it is obvious that a good deal of non-forestry expertise will indeed be required to work on the technical side of system integration. New Brunswick firms have a lot to offer the FOREMOST project in this area. Universal Systems work with GIS technology has gained it clients throughout the world. Advanced Systems and Rockwood have the expertise to provide the hardware and software necessary to design a sound "G.L.U.E." and Advanced Systems and OPTEX have the experience needed to develop the data collection systems required for maintaining updated databases. Rockwood has become well-established in the knowledge engineering,

expert systems field. In addition, GEODAT and OPTEX can provide the expertise needed to get the stand, resource and terrain data from remote sensing and satellite imagery and download it automatically to a GIS.

Again, there is a great deal of forest management planning expertise that can be tapped in the Timber Management Branch of DNRE and, increasingly, in other NB forestry consulting firms.

Participation in FOREMOST: Pros and Cons

The FOREMOST proposal can be expected to evolve quickly in response to criticisms from potential participants in the forestry sector. At this time, therefore, the benefits and costs of participating in the project that may eventually proceed are difficult to gauge with any great degree of confidence. Certainly the advantages will vary greatly with the characteristics of the final FOREMOST proposal that might be accepted and with the background and situation of a specific New Brunswick group or individual that is contemplating collaboration. For instance, except for financial or time constraints, it is difficult to see why anyone would not benefit from being in on a FOREMOST project that truly concentrates on the development of an integrated forestry planning system framework. However, the costs and problems associated with participation would definitely increase if the current ambiguity and contradictions in the proposal are not resolved.

For New Brunswick groups contemplating participation in FOREMOST, there are there are several potential advantages. All participants should benefit from the opportunity to gain knowledge and experience from a national collaborative effort, to develop and validate relevant technologies and to participate in the definition of recommended technologies and standards. Furthermore, software companies should want the enhanced access to the significant national and international markets for IFPS that participation might offer. Even if the participation is limited, some firms or individuals may benefit by simply selling expertise to the FOREMOST consortium on lucrative terms. If FOREMOST goes ahead as envisaged, it should have a fair

degree of financial backing (4.5 million dollars was estimated in the proposal), and a good portion of that would come from a consortium of forest product companies that would be the ultimate users of the final product. Therefore, depending upon the nature of the participation, a cooperating firm might be able to be able to make a handsome profit and/or sell its expertise and products to a ready-made cliental. As well, cooperating firms could be engaged in R&D that might enhance their reputation and expertise in a some specific technical area which would lead to work in future projects.

There may also be several disadvantages to participation by NB groups. As it now stands, this project will be led by the NRC laboratory in Vancouver. For New Brunswick organizations, geography may then become a factor as distance will make a cooperative effort expensive and difficult to execute. The proposal and the manner in which it has been developed lead to serious doubts about NRC's interest in the participation of all but a favoured set of developers. For some, it may also be difficult to cooperate in a project where such a great emphasis is placed on a particular technical feature: OOPS. It could easily lead to differences of opinion with respect to how the project's goals should be accomplished. A major disadvantage for organizations that are currently working in the forestry sector is that the project proposal appears to have some significant flaws. Their reputations in the industry could be damaged by their being associated with a poorly executed project. Much more than the NRC researchers, forestry sector organizations working on this project would have to live with its consequences.

Of course, those who decide not to participate in FOREMOST would not be subject to these potential benefits and disadvantages. In addition, by not joining the project, they would be free to pursue their own course of action with respect to development of IFPS technology. However, non-participation in the NRC initiative may have some disadvantages as well. For organizations currently working with the forest industry, there may well be some costs incurred by not taking part in the "national effort". Those who truly believe that an IFPS could be developed and that this would be of benefit to the

forest industry (and, indirectly, themselves), there may be a feeling that their cooperation might have helped the project achieve its goals. The fact that their reputations will have remained unsullied will be small consolation if a failed FOREMOST project turns the forest industry against the idea of IFPS in the future.

OVERVIEW OF OTHER INTEGRATED FORESTRY PLANNING SYSTEMS

Aside from the FOREMOST project there are three other projects worthy of note: the US-based TEAMS project, the Plonski Project in Ontario and the FRAS project in BC.

1) The TEAMS project

This is an integrated system developed at the Northern Arizona University's School of Forestry as a decision support system (DSS) for teaching resource management. The teaching philosophy at Northern Arizona has been to develop an integrated curriculum which culminates in developing a team-based multi-resource management plan for a forest district. A shortcoming of this approach has been that students lacked the means to synthesize and analyze the vast amounts of data required to make objective decisions. Therefore, plans tended to be fragmented and piecemeal, likely to achieve only a feasible solution, not an optimal one.

In order to overcome this problem, TEAMS (Terrestrial Ecosystem Analysis and Modelling System), a DSS for simulating forest management activities, was developed. TEAMS is a tactical planning system to help develop site-specific treatment schedules that achieve management goals and meet specified standards and guidelines. It combines a multi-resource stand simulator, a linear programming package (LINDO), a GIS (ARC/INFO), a graphics package (Microsoft CHART) in an integrated information system and DSS organized around a relational database (R:BASE 5000). All links and data transfer between the modules have been automated: the users need only to input the initial stand inventory data. Once entered, the GIS derives a series of data

summaries and maps that describe the unit's current status. Then the data is routed to the stand simulator where a series of stand management alternatives are simulated based on stand structure. Each alternative is simulated and information on projections of multi-resource outputs (water yields, forage production, sediment yields, saw-timber harvests, pulpwood harvests, pole harvests), future stand characteristics (old-growth acreage, wildlife cover and forage, scenic beauty ratings, timber variables), and economic results (net cash flow, costs, present net value) for each alternative are stored in the database. A set of alternatives can be chosen for the management plan in one of three ways: 1) directly by the user, 2) by LP in conjunction with prescribed goals, standards and guidelines, 3) using a combination of the first two options. TEAMS displays results in graphic, tabular, and map format. The user may take such results and develop and test other alternatives in response to perceived problems and opportunities. Users are provided with rapid feedback on likely consequences of management alternatives. TEAMS is thus an interactive tool that ultimately depends on human judgment and expertise to make a final decision.

Several features of the TEAMS project stand out. TEAMS is an educational tool: it is not currently a product available commercially to government or industry. However, it is stated that this project could easily be adapted to fit a real-world context. Unfortunately, the scope of the project does not appear to incorporate short term scheduling and/or operations planning. It focuses on long-term planning, although some short-term aspects of the long term plan are included. An integrated dimension does appear to have been achieved in TEAMS as many facets of resource management are capable of being simulated and monitored interdependently and computer packages have been set up to "talk" to each other, although this integration does not include feedback to monitor correlations of management plan predictions with actual stand development. Finally, the information needed for decision support was communicated adequately to the user in the form of maps, charts and graphs.

Reference:
D.B. Wood, B.E. Fox & W.W. Covington. 1989. Computer-Based Approach for Teaching Multiresource Management. Journal of Forestry. Nov. pp 11-16.

2) The FRAS Project

Current timber supply analysis techniques in B.C. no longer meets managers' needs in several key areas including: integrated resource management, location and scheduling of 20 year timber supplies, and in reconciling the actual harvest with the forest inventory. The proposed FRAS (Forest Resource and Analysis System) project involves a new analytical system to support resource planning. FRAS will be a framework which coordinates existing systems and models and addresses current management issues including economics of timber supply, impact of wildfire and pests, incremental silviculture, linkage of strategic plans to operations, and in monitoring inventory with actual harvest. The key concepts of FRAS are:

1) Area-Based: FRAS will build on a GIS technology and so will be able to take geographic location and spatial relationships into consideration. An area-based approach permits strategic plans to be linked to operations. It is also important for harvest scheduling since harvest production patterns are spatially-oriented.

2) Integrated Data: Data will be integrated so that all resource information can be collated to provide a composite resource map and data for any area.

3) Open Design: The framework of FRAS will be flexible so that additional models and data can be easily added. It will permit easy data exchange between different GIS systems and standard microcomputer software packages.

4) Short & Long Term Timber Supply Analysis: Short term (20 year) and long term (200 years) planning horizons will be considered. These analyses will be linked to ensure consistency of short term plans with long term objectives.

5) Local Decision Support: Tools, including various models and a GIS, will be provided for local managers to be used as a DSS to analyze the multitude of issues and questions that arise on a regular basis.

6) Design: FRAS will be part of a larger framework - IRMAS (Integrated Resource Management Analysis System) which will be used to analyze range, wildlife and recreation resources.

It is possible that the FRAS project will incorporate satellite image analysis to monitor harvests so that management plans can be more easily compared to reality.

It should be noted that FRAS is still under development and the conceptual linkages seems to be rather limited. Basically, FRAS is a GIS linked to a long-term growth model and a 20 year growth model. This means that FRAS is medium to long-term in scope. It does not really deal with operations and scheduling issues which have shorter time horizons. Local DSS tools are vaguely mentioned without any reference to which decisions should be supported and how they are going to be supported. However, FRAS is targeted for use on Crown-managed land in B.C. and thus is intended for industrial use. It seems that the integration envisaged in the FRAS project is rather narrow: compared to the TEAMS project which considers many management objectives, FRAS will concentrate solely on wood supply. Perhaps when FRAS is linked to the larger IRMAS project this will be rectified, but IRMAS is currently only a concept. There is some mention of monitoring actual stand development to see if it matches model predictions, but little indication of how this would be accomplished. Dellert mentions that satellite image analysis "can" be linked to forest inventory , but doesn't discuss how it could be done or even what stand parameters should be monitored.

Reference:

Dellert L.H. 1989. The Forest Resource Analysis System: A GIS-Based Decision Support System. Proceedings of the GIS '89 Symposium. March. pp 49-53.

3) The PLONSKI Project

This is a joint effort by governments, universities and ESRI Canada to develop a state-of-the-art, GIS-based, DSS for Forest management. The goal is to have in place by 1992 a complete set of

software tools with which to manage the Plonski forest (118,000 ha) in Northern Ontario. With such a system in place ESRI Canada will thus have a working demo of its GIS-based forest management software system which it intends to market across Canada to forestry organizations as a comprehensive package to meet their various needs. A stated focus of this project is to link forest management with business decisions, a major step forward in GIS development, which traditionally only organizes and analyzes digital data. The Ontario Ministry of Natural Resources (OMNR) contract with ESRI calls for a complete set of software tools, including a map and a report generator, interactive menus, linkages to corporate accounting data, transaction processing, and integrated geographic data processing. Data concerning forest inventory, wildlife, cut-block records, silvicultural treatment history other land uses will be maintained in a relational database. The system will also be able to simulate long-term wood supply and growth and yield scenarios based on different management prescriptions. It will also have the capability to undertake annual operations planning and will have a tactical planning module to link this with the long-term planning module.

Of all the integrated planning projects examined, including FOREMOST, this project seems to be the most commercially based, i.e. with a strong view to an industrial end use. This may be because ESRI Canada, in a development agreement with the OMNR, is investing a good deal of its own financial and human resources and reputation into this project. It is likely that ESRI Canada hopes to develop new products which will put it at a great advantage over its GIS competitors in the forestry market sector. The project participants admit that many technical and conceptual questions regarding the development of an integrated planning system remain to be resolved, in part because the scope of the project is so comprehensive (both in terms of planning horizons and the breadth of resources being included in the system).

References:

Olson, S. 1990. Making GIS Work. Silviculture Magazine, Vol. 5, No. 1 (Jan/Feb). Page 13.

Dan Marinigh, July 1990. Personal Communication. 705-642-3222. Dan is Project Administrator of the Plonski Project.

SUMMARY OF IFPS INITIATIVES

If the FOREMOST project is to stay with its stated objectives, the project will not result in an actual IFPS. It should, however, produce a framework which could facilitate the development of site-specific integrated systems. A specific IFPS can be built without reference to the work envisaged by NRC, although this is not as likely to result in the development of portable and marketable products and expertise. In fact, in order to properly test the alternative technologies and standards that might form a DSS framework, the FOREMOST project must be complemented by one or (preferably) more demonstration projects. The impact of FOREMOST will be greatly reduced if it is not tied to an actual integrated planning system. Of the three initiatives which are intended to produce actual IFPS applications, the Plonski project is most suited to acting as a test site. However, because the focus of the Plonski project appears to be primarily on governmental decision-making (with generally longer time horizons), it is a long way from producing a system that will integrate all the levels of planning mentioned in FOREMOST. For forest product companies, the short-term planning components of an integrated system would be vital.

As illustrated by the Plonski project, it is not necessary to wait for the results of FOREMOST to begin the design and develop an IFPS. An IFPS pilot project could be initiated without collaborating with FOREMOST. However, assuming that the FOREMOST group (NRC and cooperating firms and agencies) will concentrate on the goal of developing the "G.L.U.E." for an IFPS, cooperation between this group and the developers of an IFPS should be mutually beneficial.

SECTION IV - RECOMMENDATIONS

In order to ensure that the FOREMOST project is truly useful to the Canadian forest industry and not harmful to the RDSA and its like across the country, NRC must be convinced that it is to everyone's advantage to change its approach to the project. It should be made clear to NRC that its role should be to undertake research and development in the area of an IFPS framework, and that specific IFPSs should be developed by groups who have the expertise to do so. As well, it is obvious, from the FOREMOST prospectus and the presentation in Fredericton on September 27th, that the NRC personnel involved in this initiative are inadequately cognizant of Canadian IFPS researchers and developers and their work. It should be made clear to them that much of the expertise required to develop an IFPS exists in New Brunswick. In order to accomplish this a document (perhaps incorporating relevant parts of this report) that focuses on the problems in the FOREMOST prospectus and on the capabilities in this province, should be presented to the appropriate NRC officials as soon as possible. Since a properly-structured FOREMOST project would focus on the framework of an IFPS DSS, a New Brunswick pilot project should be suggested as a means of strengthening and supporting the FOREMOST project. Such a New Brunswick pilot project, much more than the Plonski undertaking, could offer a truly comprehensive IFPS environment in which to test FOREMOST's technologies.

However, if the development and management philosophies of NRC in this project do not change, these same delegates should express their feelings on the matter, strongly, and should lobby the appropriate government departments to intercede on behalf of the province's software firms, consultants and researchers.

Regardless of the outcome of the FOREMOST prospectus, the forestry software industry (and researchers) in New Brunswick should continue to explore the possibility of future collaboration in the area of information systems for the forest industry. Members of the industry could share market information and development ideas in many

areas where their efforts would be complementary, rather than competitive. In many cases the blends of expertise that could be offered to potential clients in collaborative efforts would be a major selling point for the province's technologies.

The Resource Decision System Association, if continued, could help foster such collaboration and ensure a more effective joint response to future forestry software initiatives. Furthermore, it could act as a focal point for lobbying efforts related to government support and the contracting out of government forestry-related projects. The RDSA could also be a clearing-house for information regarding R&D efforts, market opportunities and problems.

It must be recognized that member firms and individuals would not have much time for organizing and maintaining such an association. As well, it would not be necessary to create an entirely new structure to achieve these goals if an organization such as the Champlain Institute could offer the RDSA its support, perhaps by helping to publish a RDSA newsletter, should that be seen as worthwhile. Another possibility would be for the RDSA to become a technical committee in a New Brunswick Geomatics Association, should it be formed in the near future.

The members of the New Brunswick forestry software community should lobby for a "made-in-New Brunswick" IFPS project since this would help to accomplish many of the goals of the group. An application-oriented demonstration project in this province would not compete with FOREMOST: it could be used to validate and complement the technologies described in the proposal. Nevertheless, a New Brunswick project could survive on its own merits since it could be used as an opportunity to test cooperative approaches and demonstrate the individual products and services of the group. A successful IFPS would promote continued collaboration (perhaps through RDSA or consortia) and could be a stepping stone to similar endeavours nationally and internationally.

In fact, a "made-in-New Brunswick" IFPS project has the potential to derive many benefits for the client, private and public forestry sectors, software and consulting firms, and the universities in this

province. Furthermore, such a project, if successful, would indirectly benefit all of the province by developing local R&D expertise and, more generally, helping to foster more of a "can-do" attitude with respect to new technologies.

More specifically, the advantages that can be expected are the following:

For the Client - This should be a good opportunity to acquire, at a low risk and cost, a technology that they will eventually be required to have in any case. The design of the project would incorporate a maximum amount of support (hand-holding) so that the client's personnel would gain a good understanding of and experience with integrated planning and relevant computer technologies. Most importantly, a good IFPS will enhance their managers' abilities to plan and control their operations, and document and justify their decisions and actions.

For the Dept. of NRE - Besides developing a better planning, control and documentation system for one of its principal licensees, an IFPS project will enable the department to gain experience with the integrated planning concept (which can then be applied to other licensees) and new computer technologies. This knowledge should eventually enable DNRE (along with other government departments) to develop more broadly integrative (economic, environmental, social) strategic analysis and planning capabilities. As well, this project could provide a safe, non-intrusive approach to evaluating the CARIS system with respect to its capabilities vis-a-vis Timber Management Branch requirements.

For the NB Software/Consulting Industry - Participation in a visibly-successful IFPS project will result in readily-marketable expertise and products to forest product companies and government agencies throughout the world, directly and through the Canadian International Development Agency. Such a

project would be controlled by the province's industry and they should be able to reap most of the benefits.

For the universities - This project would enable them to participate in a larger-scale, well-financed project that would provide opportunities to advance individual research goals, especially in terms of testing integrational ideas and models.

APPENDICES

APPENDIX I

NB ORGANIZATIONS WITH IFPS STRENGTHS

ADVANCED SYSTEMS DESIGN LTD.

ASD has expertise in data acquisition and data communication with specialization in such areas as:

1) Industrial Computer-Based Data Acquisition
2) Data Communications and Computer Networks
3) General system integration via communication networks from LANs to MSAT satellite networks.

ASD has developed commercial Log and Lumber Tally Systems and data collectors as parts of integrated systems where field data is sent via cellular telephone or MSAT satellite to central computer systems for immediate processing and verification.

In addition the personnel of ASD have strong academic and research experience in the area of data communication and maintain a R&D laboratory to satisfy the specialized needs of clients. ASD has undertaken projects in New Brunswick and Western Canada and market their products in Canada and the U.S. through representatives.

GEODAT INFORMATION SERVICES LTD.

GEODAT specializes in providing fully integrated remote sensing, GIS and digital mapping services. Aside from several geological and mineral mapping operations, GEODAT is also directly involved in the following forestry applications:

1) monitoring of acid fog effects in the Bay of Fundy for Forestry Canada;
2) monitoring and map production of clearcuts and forest fire depletions using LANDSAT-TM imagery for the New Brunswick Timber Management Branch;
3) research (in collaboration with Forestry Canada) in the fields of satellite forest inventory, insect and fire damage assessment, species identification, stand classification and delineation.

In addition, GEODAT has the capability to carry out broad-based environmental assessments such as monitoring of soil erosion, pollution effects, drainage patterns and forest vegetation moisture stress using satellite imagery. GEODAT also has expertise in using airborne radar to classify and map forested areas.

GEODAT is one of the few companies in Canada that have an established digital link between an Image Analysis System and a GIS. This link provides an efficient means of producing accurate up-to-date maps at any scale. New remote sensing data can be integrated quickly with a GIS in order to update the forest management database. GEODAT has worked with most existing GISs on the market today including SPANS, ARC/INFO, CARIS, INTERGRAPH and GEOBASE. GEODAT's projects and clients are Canadian, with the bulk of their work being in the Maritimes.

OPTEX INC.

OPTEX is a newly established New Brunswick software development firm specializing in imaging/optical scanning and storage systems. The founders of OPTEX have extensive backgrounds in imaging systems development and image analysis/geographic information services. OPTEX draws on this experience to provide the following services: software research and design, imaging system development, GIS development, consulting services, implementation of turn-key imaging systems.

R/EMS RESEARCH LTD.

R/EMS specializes in software development and consulting in resource management, particularly with regard to wildland fire management and environmental assessment. R/EMS offers four main products/services:

1) Software Systems which gather and analyze large amounts of data and transform them into useful graphic information.
2) Consulting Services in resource management.
3) Educational Software using computer games and models.
4) Seminars, Workshops and Training Sessions.

Current activities at R/EMS include the development of management plans for national parks, wood supply analysis for a major industry, wood supply and harvesting model for a marketing board, development of a GIS database for 40,000 sq. km. of boreal landscape, development of a fire growth model in collaboration with a leading GIS company, and the design of satellite capture and filtering software for a national fire danger display system.

The personnel at R/EMS have extensive experience developing simulation models and decision support systems incorporating computer graphics, and interfacing these with existing technologies such as a GIS, all within a forest management context.

R/EMS has strategic partnerships with companies across Canada to expand their capabilities to meet specialized needs. They have clients in universities, the government and industry in every province and territory in Canada. They also have clients in New Zealand and are currently looking to expand into the U.S., Australia and China.

ROCKWOOD INFORMATICS

ROCKWOOD is a company engaged in the production of software and the development, integration and servicing of large scale systems. It has the ability to offer both hardware and software expertise and has won major contracts (over $300 000) in both of these areas. ROCKWOOD is involved in:

- Systems Integration
- Software Development
- Turn-key Systems and Project Management
- Knowledge Engineering and Expert Systems Development

In conjunction with these services, ROCKWOOD provides a variety of services in Data Processing consulting including strategic planning, evaluation of proposals and feasibility studies. ROCKWOOD provides a full range of support services including: user training, hardware and software maintenance, data entry and backup services. With offices in Fredericton and Ottawa its market area is mainly in the Maritimes and Central Canada.

ROCKWOOD is developing an expert system for New Brunswick DNRE to help in the management of the White-tailed deer population. Using empirical evidence and subjective judgement, it will provide recommendations to determine the number of deer permits.

FORCE/ROBAK ASSOCIATES LTD.

FRA is engaged in the design, development and servicing of micro-computer based decision support systems for the forest operations industry. FRA offers a range of decision support products and services. At the lower end, FRA has developed information systems which can be used for gathering and maintaining machine and natural resource data, and processing and presenting this data as machine performance statistics, machine rental rates, and merchantable wood volumes useful for lower level decision-making.

At the other end of the spectrum FRA has developed OP-PLAN, a DSS for use in operational planning of forest operations at the company, district and/or camp level. OP-PLAN aids the managers in planning their harvesting, hauling, road construction and maintenance, overhead functions and silviculture. OP-PLAN calculates and presents the budget automatically that results from this plan, at any stage in the plan's development. As well, OP-PLAN keeps track of such information as machine hours, product volumes and costs, roadside inventories, volumes transported to any of several destinations. OP-PLAN can also address short term scheduling and costing of any operation. Because OP-PLAN allows multi-year planning, it can be used to develop tactical 5 year plans as well as annual operating plans. Thus, the power of OP-PLAN is its breadth in planning scope. It can be used for short-term planning or tactical planning and thus serves as a good linkage point to long-range forest management planning systems.

FRA has sold software packages to governmental organizations, marketing boards, a research institution, forest product companies and educational institutions throughout Canada. OP-PLAN has been translated into four languages and is being used by Quebec forest products company and nine universities in eight countries.

UNIVERSAL SYSTEMS LTD.

USL is a software and systems integration company that markets and supports the CARIS GIS (Geographic Information System). The CARIS system has extensive applications in digital mapping and the management of land and marine resource. This would include such applications as forest management, topographic mapping, remote sensing, and transportation planning. CARIS is capable of compiling, storing and analyzing spatially-oriented information. In addition, the system supports full topology and a true three dimensional data structure and an integrated raster/vector environment. CARIS is supported on many hardware platforms, operates under both VMS and UNIX systems, and incorporates industry standards such as X-Windows and Motif in all its applications.

USL's emphasis on R&D (approximately one-third of its personnel) has led to a dramatic growth in CARIS over the past five years. This has resulted in an expanded diversity of CARIS applications and, consequently, an increase in the number of client. USL's forestry clients include: Fletcher Challenge, PEI Energy & Forestry, B.C. Crown Lands, and Manitoba Natural Resources. In addition USL boasts an international clientele including: The Port of Singapore, Denmark Survey and Cadastre, Egypt Soils & Water, Deutsches Hydrographisches Institut, Netherlands Hydrographic Service, and Geographic Information-Australia.

ELECTRONICALLY ENHANCED EDUCATION INC.

E^3 designs, develops and delivers training solutions for both the public and private sector. The company is involved in research into learning problems and solutions, often integrating the traditional classroom learning environment with electronic and computer aided tools to achieve the best learning environment. E^3 specializes in linking Audio-Visual equipment to computer software and developing computer based training/educational packages. They are currently working or bidding on such domestic projects as:

1) developing an equipment recognition trainer for use by Canada & NATO in identifying armoured vehicles and aircraft;

2) a hospital training package;

3) developing a training package for electronic maintenance on the Canadian Patrol Frigate Program;

4) developing a "distance learning" package for use in training the Native Peoples of Canada.

The personnel of E^3 have extensive experience in the psychology of learning and the programming experience needed to develop computer-based educational packages, are able to conduct practical R&D projects in the business environment.

UNIVERSITE DE MONCTON - SCHOOL OF FOREST SCIENCE

There are four main thrusts of R&D of computer-based models for forest management at U de M:

1) Forest growth and yield models

Three models have been developed to forecast growth and yield of forest stands in New Brunswick. The objective of this project is to provide versions of the models to licensees for use in wood supply analysis for the development of forest management plans. The three models forecast the forest stand at three stages of maturity: establishment phase for regenerating stands, growth phase for maturing stands, and a stable/decline phase for mature/overmature stands.

2) Integration of remote sensing data and GIS

Projects to develop, correlate and validate Landsat-TM imagery were pursued. The main goals were to standardize complementary imagery and to strengthen correlations between images and ground conditions. Another project was to study the suitability of using airborne MEIS imagery to map spruce budworm defoliation. Airborne data was compared with ground plots to see if accurate correlations between images and ground conditions existed.

3) Financial and economic analysis of forest operations

Three main areas of economic study are being pursued: investment

analysis of forest harvesting systems; socio-economic impacts of changes in logging technology; optimising the choice of harvesting systems in a 5-year planning horizon. The investment analysis work allows managers to group logging and transportation machines into different classes and compare systems on the basis of financial criteria. In the socio-economic models financial analyses are conducted for the household, private sector and the public sector rather than for just the private sector. This allows studies on the effect of logging changes on tax revenues, household revenues, social welfare programs and other variables. In the work on choice optimization of logging systems, output from a long-term timber supply model, cost information, and productivities are used in dynamic and linear programming models to propose an optimal logging system from a list of possibilities defined by the user.

4) Integrating ecological and economic factors in forest-level planning

A cartographic model (for implementation on a GIS) is being developed for use in the identification and mapping of landscape units differentiated by site type. Potential productivity of each site type will be determined from stem analysis data. L.P-based harvest scheduling models will be used to evaluate management implications related to conversion from a stand-based stratification to a site type based stratification.

UNIVERSITY OF NEW BRUNSWICK, FACULTY OF FORESTRY

The computer-based forest management planning systems being developed by the Forest Management Group of research professors comprises the main effort in this area at UNB. Their programme involves R&D in various computer-based forest resource and forest operation management applications, especially the integration of non-spatial and spatial data processing techniques in forecasting, harvest scheduling, harvest distribution, renewal and protection, that link

management and operating plans. Their work is summarized in the following project groups:

1) Harvest Schedule Implementation Model

One of the major obstacles to using LP-based harvest schedules is that the results are difficult to interpret and implement in terms of actual forest stands and their geographic locations. To deal with this obstacle a computer-based system is being developed that considers site-specific costs and spatial constraints so that forest managers are given the scheduling information on a map-based format with the differences between this map-based format and the "optimal" LP-solution quantified. This is being accomplished by developing software that link the LP-solution with a GIS.

2) Cartographic Modelling of Riparian Buffers

Leaving buffers of standing trees around a forest stream is a standard practice in logging operations to provide for the environmental protection of the stream. The widths of these riparian buffers are determined by both quantitative and qualitative criteria. The qualitative criteria creates uncertainty as the final widths are not determined in an objective, repeatable manner. The objective of this research is to use algorithms solely based on quantitative data to calculate buffer widths. This data is readily available as mappable information. Therefore a GIS is used to analyze mapped data to design buffers to meet the many environmental conditions necessary.

3) Harvest Distribution and Transportation

The transportation of wood from many different cut-blocks to many different mills involves a complex transportation network. Currently no formal method is used to ensure that this transportation network is optimized. The objective of this project is to see if it is possible to reduce transport costs and administrative costs by using mathematical optimizing techniques to develop an improved transportation model.

However, this project permits human override in that it first allows manual allocation of harvest blocks to specific mills (for whatever reasons), and only then submits unallocated harvest blocks to mathematical optimizing.

4) Linking Strategic and Operational Planning

Harvest scheduling, usually accomplished through LP techniques, must be linked to operational harvest area selection by a tactical planning process in which there is an effective and efficient interchange of information between the scheduling and operational planning levels. This linkage can be provided, to a great extent, by tying planning decisions at operational and strategic levels to specific geographic locations. This project is studying: a) the identification of spatially-dependent information that must be transmitted, b) how this information is used in the decision-making process and c) how such information is most appropriately presented to decision-makers.

5) Object-Oriented Data Structures for Forestry Applications

Most GISs instead emphasize vector encoding because raster encoding requires much greater data storage requirements. A conceptual framework for raster-based analysis functions has been proposed in the research literature, but is for the most part impractical to implement in vector-based GIS technology. This project seeks to develop a storage-efficient raster-based data structure. In addition, raster-based technologies do not support spatial objects, which are identifiable entities. The objectives in this project are to: a) design an object-oriented raster data structure, and b) develop raster-based functions that are efficient.

Other Expertise in the Province

It must be recognized that there are individuals and groups in NB who have expertise relevant to IFPS, whether in relation to integrated planning in general or specific modelling, data or computer

technology topics. Personnel in the Timber Management Branch of DNRE have much experience in the use of GIS and models in forest management planning. Other Departments at UNB conduct research and development in GIS and areas related to software integration. There are other consulting and technology firms in the province who may have relevant experience but who have not yet responded to this survey.

APPENDIX II

A Critique of the Technical Section of the FOREMOST Prospectus

1) Short Term Scheduling:

NRC's interest in the application of "dramatization" to help managers solve scheduling problems is quite understandable. There are several simulation software packages of this type that have been found useful for some of these kinds of problems. AUDITION's "theatrical paradigm" should allow users to simulate series of events occurring over time and therefore it should help to identify and solve potential bottlenecks in the timing of events and the short-term allocation of production resources. However, in the background to the short-term scheduling stage of the FOREMOST prospectus it is mentioned that variabilities in the scheduling of work can effect mill production and hence profitability. Since the mill schedules must to be included in the scheduling decision process then wood transportation must also be included, but this is not even mentioned in the prospectus. This is a rather glaring omission considering the fact that in many parts of the world operation managers feel that it is in the wood transport aspect of scheduling where most decision support is currently required. As well, in many operations, tertiary road construction and road maintenance scheduling is closely tied to harvesting, silviculture and wood transportation schedules. Certainly wood transportation and road systems must be included if scheduling decisions are to be truly integrated. It is difficult to excuse this omission as being simply a result of the general nature of the prospectus since issues related to scheduling of the harvesting and silvicultural operations are discussed in great detail.

2) Annual Operating Plan:

The application of AUDITION and OOPS to the annual operation planning problem is not well justified. There is certainly

merit in linking operation planning models and GIS in order to improve annual planning and its integration with other planning, but it is unclear why the technology proposed by NRC should necessarily be the one used to accomplish this. Also, although the need for plan integration is the rationale for FOREMOST, there is little description of the data and information must be shared with other planning levels (short-term scheduling or medium or long-term planning) or at what points in the planning process such data/information transfer is required. It is even more alarming, however, that the authours of the FOREMOST proposal do not appear to recognize the importance of integrating elements of the operational plan itself. Decisions regarding cut area choice, product mix, harvesting methods, silvicultural operations, road networks, wood transportation and support functions are interrelated, but this seems imperfectly understood by the FOREMOST proponents. It is strange that a proposal that stresses integration should pass so lightly over an area where lack of integration leads so clearly to sub-optimization. The evaluation of operational alternatives must be based, to a great extent, on their effects on machine and system costs, product costs and revenues, the overall operational budget and the risks that these choices entail. Not only are these essential information requirements not mentioned in the proposal, but entire operational elements (such as wood transportation) are ignored.

3) **5-year, 20-year and Long-term Forest Resource Planning:**

Lack of good (and relevant) data has been a major impediment to the implementation of improved forestry planning processes. The FOREMOST proposal gives little indication to how the data necessary for more effective and integrated decision-making would be obtained for any of the planning stages. In order to get FOREMOST to work, NRC envisages collecting detailed data on equipment, forest inventory, pre-cut on-site timber, forest cover, understorey, watershed, hydrography, topography, slope,

aspect, elevation, wildlife, recreation, soil, etc. The danger with this is that a system may be developed which requires data that industrial users do not have and are unable (or unwilling) to collect. There are currently forestry companies that do not do operational cruising because it is considered too expensive and not worth the effort. The question of data acquisition must be properly addressed if FOREMOST is to progress beyond a laboratory setting.

The proposal is weak in its description of decision processes even before integrational aspects are addressed. It is reasonable, of course, that all the specific analyses that must be undertaken in the planning processes would not be described in a proposal whose goal is to provide a framework for integration. However, since actual decision processes are to be linked, how are the specific decisions to be identified and described as the project proceeds? As it now stands, there is a great danger that the project could achieve its design specifications (deliverables), but still not result in anything that is remotely effective in supporting integrated decision-making.

Development of medium and long-term forestry plans requires a substantial amount of investment analysis, especially if these plans are to be properly integrated. In areas where faster-growing forest plantations were established primarily for industrial reason (U.S., Britain, New Zealand and Australia, for instance) there has been a fair amount of work done in incorporating investment analysis in the forest resource planning process. As well, more recently, organizations in many of these countries have taken steps to integrate medium-term financial decision-making more closely with the long-term forest investment analysis. In Canada, there are usually very long time horizons associated with forest resource planning and the forest owners (usually the provinces) are not necessarily timber

users, so that there has been less emphasis on well-integrated financial decision-making. As the FOREMOST proposal indicates, the data and models associated with these decision processes are often poorly structured and not well developed. What is unfortunate is that the FOREMOST proposal inadequately addresses questions relating to what the relevant decisions are, how the necessary data will be acquired, what parts of the planning processes must be integrated (and how), and practically ignores the investment and financial issues related to linking short, medium and long-term planning.

What decisions at the longer-term planning levels must be linked to the 5-year plan and operating plans? What models and data-sharing must be used to produce information that supports integrated decision-making? It can be easily argued that "present planning procedures are static and not particularly well integrated", but these integrational aspects must be understood and delineated before integrated systems can be designed. The coordination of logistical factors is stressed in the proposal, but financial, physical, social and environmental considerations must also be given attention if better planning processes are to be designed. As it now stands the FOREMOST planning system may end up being user-friendly and visually attractive but not truly supportive of valid integrative decision-making.